Summary and Next Steps
Renewable Energy Modeling Series
Using Estimates of Monetary Value of
Environmental Effects of Renewable Energy
November 7, 2003

Results Summary

Introduction

Laura Vimmerstedt, National Renewable Energy Laboratory (NREL), introduced the meeting and thanked the other co-sponsors of the meeting—American Council On Renewable Energy (ACORE), U.S. Environmental Protection Agency (EPA), Energy Information Administration (EIA), and the Department of Energy. Laura explained while most of NREL's activities are headquartered in Colorado, the small DC-based office houses many of the energy analysts that deal with renewable energy modeling issues discussed in this meeting. Laura reviewed NREL's interest in the Renewable Energy Modeling Series—to help foster dialogues among energy modelers with the goal to discuss issues for modeling renewable energy and identify improvements (e.g., type of information provided to decisions makers). She quickly summarized previous meeting results, highlighted some of the topics discussed to date, and suggested some goals for this and subsequent meetings.

The first Renewable Energy Modeling Series meeting, held in October 2002, convened policy makers to identify their renewable energy modeling and analysis needs. The second and third meetings (held in February and June 2003, respectively) focused on issues from wind energy modeling. Formal consideration of this topic is complete but follow-up on wind modeling issues continues behind the scenes. The June 2003 meeting also introduced consideration of environmental externalities in energy modeling. This meeting concludes the consideration of externalities in energy models. The morning session focused on issues relating to green power (e.g., consumers interest), while the afternoon sessions dealt with quantification issues (e.g., health impacts).

Laura also provided Mike Eckhart from ACORE with an opportunity to provide an overview. In particular, ACORE strives to provide better information on renewable energy and increase communications with policy makers. One of the latest developments is a renewable energy book that will be published every year.

Morning Session: Energy Modeling Application of Green Power Market Data and Green Power Market Model Outputs

Reflecting a Dynamic Marketplace in the Adoption of Renewable Energy Technologies

Skip Laitner, EPA's Office of Atmospheric Programs, served as the morning session chair and opened with a brief presentation that introduced topics to be covered by the presentations and set the tone for subsequent discussion. Skip also provided a list of recommended reading to accompany these discussions (see presentation).

Issues in Applying Green Power Market Data and Modeling in Energy Modeling

Walter Short, NREL, presented "Issues in Modeling Green Power," which provided a quick overview of what energy modelers need to know about green power. He briefly described the scope, capabilities, and data issues faced by modelers. Walter encouraged participants to keep several questions in mind as the morning session progressed so the audience could come back to these topics for confirmation or discussion (see presentation).

Incorporating Green Power Demand into Energy Modeling

George Backus, Policy Assessment Corporation, presented "Incorporating Consumer Preferences into Green Power Market Analysis," which sought to look beyond price for why people choose green power. He explained that modeling is an efficient means to test renewable energy policy without the risk of inappropriate and costly implementation. He used the California deregulation as an example of where models predicted the eventual problems that plagued the state energy sector. George reviewed methods for modeling market choices (e.g., elasticity, algorithms, qualitative choice theory) and explained the nuances of each. He emphasized that Qualitative Choice Theory (QCT)—also called Random Utility Maximization (RUM)—models human decision-response to imperfect or uncertain information. While consumers might not understand choice, there is confidence in the results. George presented several diagrams on the distribution of choice, market share, and uncertainty with particular emphasis on preferences (see presentation). He also reviewed how decision-makers tend to make policy decisions and how it differs from consumers' selection process. He explained that uncertainty is mostly due to lack of education (i.e., no time to learn) than ability to know. In the green power realm, Renewable Portfolio Standards (RPSs) or mandates help force the learning process by making the utilities provide and consumers accept renewable energy. However, green power pricing (e.g., premiums) reduces preference for renewable energy. In the interest of time, George did not cover the Energy 2020 Model results included in his presentation but complete details are contained in the slides.

Green Power Data Issues

Blair Swezey, NREL, presented "Green Power Market and Data Issues," which provided an overview of green power markets, raised discussion points for data issues, and highlighted NREL's green power market forecast study. Blair opened his presentation with definitions or descriptors associated with green power. He then provided an overview of existing utility green pricing programs and explained the difference with green power marketing programs offered in competitive retail markets (e.g., states with deregulated or restructured electric utilities). Blair also described renewable energy certificates (RECs) and how they can be used to satisfy green power needs in both regulated and voluntary green power markets. RECs provide an advantage that allows the green power source to be built where the greatest potential/cost efficiency exists (e.g., wind turbines in the Southwest). He reviewed existing and planned renewables capacity to supply green power markets and pointed out distinctions that exist between resources built specifically to supply/sell green power versus those undertaken for other economic purposes (e.g., expansion, upgrades). Blair also explained that official green power data collection is currently lacking. While NREL's annual questionnaire to targeted utilities has a 75 percent response rate, it does not paint the entire picture. He went on to say that the Center for Resource Solutions (CRS) annual audit only covers *Green-e* certified suppliers and there is some limited information available in state deregulation reports, but no comprehensive source exists. Blair also provided an overview of the "Forecasting the Growth of Green Power Markets in the United States" study published in March 2001. He reviewed the study's purpose, approach, results, and key sensitivities and market determining factors. Lastly, he identified the emerging opportunities for green power, which include customer aggregation (i.e., collective purchasing), large customer demand (e.g., retail users), and expanded REC use.

Following his presentation, Blair responded to questions from the audience. One attendee wondered if utilities use green power offerings to avoid fuel adjustment fees. Blair explained that in the case of Austin Energy, the green power rate has been locked in under contracts so it would not fluctuate regardless of changing fuel adjustments. Matt Clouse (EPA) added that situation greatly appeals to business because they know what their energy costs will be from year to year within the contract. Kevin Cooney (Stratus Consulting) asked is there is a standard or federal green power definition. Blair commented that people in the green power market have been looking for one but in its absence, use the CRS definition as the default. He also mentioned that the National Association of Attorneys' General have created national green power marketing guidelines, which have impacted the industry. Tom Petersik (DOE) asked if administrative and marketing costs are included in green power premiums. Blair responded that it varies by provider—some view it as a cost of doing business (i.e., 20 to 40 percent of the premium might be attributable to marketing costs) but others embed these fees even if the cost for the green power is less than traditional energy sources. Another participant asked if green power programs reveal the price (e.g., keep premiums separate) to influence consumer preference. Blair said that when consumers are surveyed on their willingness to pay more, there are fewer takers when the price is revealed.

Observations on Green Power Purchasing Trends: Business and Institutional Customers

Matt Clouse, EPA's Green Power Partnership (GPP) Program, delivered a presentation entitled "Observations in Non-Residential Green Power Purchasing Trends" based on ad hoc data collected from GPP participants. Matt opened with an overview of GPP, explaining it's a voluntary partnership launched in July 2001 with a primary goal to expand markets for green power while lowering air pollution and reducing GHGs associated with electricity consumption. To date, more than 200 partners have signed up and made annual green power commitments totally 1 million MWh. The program is open to any organization (e.g., large or small end users, public or private entities) in the non-residential marketplace interested in purchasing green power. Participation might be at the facility level (U.S. facilities only), an aggregate of facilities, or the entire entity. Matt reviewed the partner electrical load categories and the percentage of annual electricity use that should comprise green power, which can be viewed in the presentation. He also provided at glimpse of how the partnership has grown due to increases in: green power commitments, use of green power as a percentage of load, and the portions of new renewables (which are defined as resources installed or repowered after January 1997). Matt described the types of markets (e.g., green pricing, RECs) from which partners are buying green power and the source of renewables (e.g., solar, wind, biogas). Lastly, he shared reasons why partners are buying green power including: meeting organizational environmental objectives, enhancing image or brand, strengthening stakeholder relationship, diversifying their generation portfolio, or tracking GHG reduction credit potential.

Participant inquiries following Matt's presentation focused on why large corporations are interested in green power. Matt responded that many are driven by likelihood of future carbon or NOx trading markets and the need to have credible records in place. Awareness and accessibility to green power markets also are being addressed by EPA.

Green Power Market Models

Jim McVeigh, Princeton Energy Resources International (PERI), provided a deeper look into green power markets and the use of PERI's Green Power Market Model (GPMM). He opened by explaining that green power markets fall into two categories—green marketing programs (deregulated markets) and green pricing programs (regulated markets)—and revealed the nuances of each. He described the options for modeling green power, which include estimating demand (e.g., consumers' willingness to pay, market penetration) or estimating green power premiums. Jim provided a comprehensive overview of the issues associated with modeling green power markets and PERI's GPMM. GPMM is a Microsoft Excel-based program that projects expected green revenues from a base of anticipated green power customers. The model includes many variables (e.g., capacity factors, multiple competing technologies, regionalized approach). The model also accounts for several state-by-state assumptions regarding utility restructuring and the availability of, customer access to, and participation in green pricing programs (see presentation for greater detail). GPMM makes certain cost assumptions based on DOE/EPRI data and includes other input data sources for green power capacity (i.e., Million Solar Roofs). The model

was designed to project additional capacity for the time frame from 2005 to 2035 in 5 year increments. The first incremental results (FY05) revealed that solar and wind technologies will provide the bulk of new capacity at approximately 40 percent each, while geothermal and biomass were limited. Jim stated comparison of the GPMM results to real world experience taken from NREL's report suggest the FY05 GPMM is conservative in its predictions (see Table 3 of presentation).

Audience questions included clarification on consideration of "value-added" versus price issues for green power and Jim responded that modifying for Lambda in the equation accounts for this phenomenon. He also clarified that GPMM excludes RECs from consideration. There was also discussion regarding the impact of MSR and EIA's "Floors" programs on the results from the model (e.g., only looked at solar electricity, not thermal). Jim added that future additions to GPMM might include looking at fuel source displacement (e.g., coal) as a result of switching to green power.

Perspective on Issues for Energy Modeling

To recap the morning session, **Walter Short** (NREL) returned the group's attention to the questions he posed in his initial presentation. The definition of green power was focused on renewable energy according to Blair Swezey, while Jim McVeigh's work relied upon regional definitions. Different types of decisions and decision-makers are important in each of the different green power markets (i.e., green pricing, green power marketing, and RECs). Speakers noted that "learning" can encompass different phenomena: technology improvement on the one hand and market awareness on the other. Speakers also pointed out the variation in green power over time and across regions, largely dependent on where and when green power programs might operate. Success in modeling green power might also depend on quality control and on what approaches are used to represent green power market details in models. In terms of data, Blair's presentation started to address the question of how much green power could be expected, and Matt Clouse's GPP presentation provided data on what types of customers have already purchased green power. Discussion ensued on how green power markets might grow in the absence of state mandates. Matt explained that when the Texas green power market failed to show results, the state pursued RPSs so the excess power generated could help spur the green power markets. In most instances, portfolio standards only require 3 percent of power come from renewable resources, but in the case of Green Mountain's offerings, it comprises 100 percent. Several questions were raised regarding green power premiums and the perception that green power is more expensive than conventional electricity generation (e.g., fossil fuels). Blair Swezey reiterated that some power providers charge premiums as a cost of doing business, regardless of actual cost for green power. Some utilities also see this as an opportunity to charge lower rates (offset by the green power premiums) to other customers. Members of the audience questioned why competitive markets do not drive down the price of green power. Blair noted that RECs are helping to drive green power costs down (particularly in regions where the least-cost power option for wind is not feasible, such as the Southeast). Several attendees continued to express discomfort that green power premiums allow some utilities to just make more money.

Blair explained the intermediate and long-term marketing objectives that drive utilities to build green power projects, and noted that imposing green power premiums has been an approach to encourage utility investment that would not otherwise occur, and that this can co-exist with renewable energy investments that utilities would make anyway (as has occurred in Colorado). Mary Beth Zimmerman (DOE) raised the issue whether green power marketing perpetuates a myth that renewable energy is more expensive in order to sustain higher green power prices/premiums, and a related question arose whether green power is a long-term market. George Backus (PAC) added that these markets are still in transition and the long-term effects remain to be seen. Attendees also discussed the vulnerability for power providers to reveal the true costs of green power. Matt Clouse indicated the utilities have expressed reluctance because it would require them to reveal what else they have/use in the rest of their power portfolio (e.g., pollution producing sources). Jim McVeigh (PERI) also described the challenge associated with including or excluding capital costs for green power projects in premiums, especially when it is unclear whether the project was built in response to green power demand or merely to expand capacity.

Participants also discussed the effects of dispatch in light of various models (e.g., NEMS). George reviewed the economic factors associated with dispatch. Laura Vimmerstedt (NREL) clarified the difference between dispatch and capacity. In response to Mary Beth's question on how to distinguish between green power market results and RPS, Blair stated that it should be kept separate. He continued by saying that because suppliers are concerned with compliance and regulation issues, NREL's data accounts for green power above RSP requirements (particularly for *Green-e* certified sources) to avoid double counting. Matt added that power producer and product credibility will help ensure there is no double counting in the marketplace. There was also a discussion of the data needs necessary to include green power in a model such as NEMS. For example, an additional amount of renewable energy—above the RPS requirement—would need to be specified for each region, so that it was clear how much renewable energy stock was meeting green power demand and how much was fulfilling RPS requirements.

Afternoon Session: Panel Discussion - Estimates of Emission Effects and Their Potential Uses in Energy Modeling

Session Chair Julie Hewitt, EPA's National Center for Environmental Economics, explained the afternoon sessions would focus on the intrinsic value of green power—to reduce GHG emissions and other harmful pollutants. Her office reviews regulation and takes into consideration the economic impacts of environmental control. The purpose of the afternoon session was to focus on some of the co-benefits (e.g., health impacts) associated with switching to green power and provide an overview of several models that can help determine those benefits. Laura also reminded participants to review the "Average Displaced Emissions Rate" methodology fact sheet in the workshop folder.

Estimating the Monetary Value of Emissions Reductions

Bryan Hubbell, EPA's Innovative Strategies and Economics Group, presented "Benefits Analysis of Air Pollution Policies and Regulation" and explained that EPA is moving toward tracking air emission reductions and where/how these emissions reduction have the greatest impact. According to Bryan, emissions reductions associated with switching to renewable energy technologies (versus fossil fuel combustion) are considered one of the major benefits. Methods and results from benefits analysis of air pollution policies and regulations might help energy modelers to quantify these effects. Bryan provided on overview of the elements of a benefits analysis (see flow chart in presentation). Specifically, he explained how EPA selects the health outcomes (e.g., mortality, asthma ER visits) to include in benefits analysis based on emerging public health impacts. Critical sources of information include incidence rate, affected populations, estimated pollutant effect coefficients, and modeled changes in ambient air pollution. However, there are also areas of uncertainty (e.g., extrapolation of impacts in the Northwest based on limited regional data).

Bryan raised the issue of how much does one value improvements to public health (e.g., cost of illness in reduced sick days or willingness to pay to reduce premature deaths). EPA developed the Environmental Benefits Mapping and Analysis Program or "BenMAP" to allow analysts to conduct benefits analysis in-house simply, quickly, and cheaply. BenMAP uses a wide variety of air quality data—both monitored and modeled—to map health impacts associated with air pollution (e.g., poor air quality and mortality incidence rates). Intended for public use, BenMAP exports the results in easy-to-understand Excel spreadsheets or GIS maps. Results of recent BenMAP analysis include a $113 billion value in emissions reductions associated with NOx and SO_2 caps (see presentation for specific health benefits and other examples).

Audience questions dealt with perceived simplicity of the model. Bryan explained BenMAP was intended to serve as "back-of-the-envelope" analysis for policy decision makers to help them attach a health price to regulation. The purpose in this context was to raise awareness of environmental externalities (i.e., co-benefits) of green power to the energy modelers in attendance. Zia Haq (EIA) added the importance of fostering dialogue between analysts and modelers to develop better energy input to BenMAP, and then using the calculated societal costs achieved in NEMS to better account for impacts. Bryan also pointed to flexibility in using specific, locational data for green power capacity, especially for NOx and SO_2—better information yields better results.

Emissions Reductions Valuation: Initial Results

Denise Mulholland, EPA's State and Local Capacity Building Branch, delivered a presentation entitled "Estimating and Valuing Human Health Effects of State and Local Emissions Reductions." Denise explained that EPA supports state and local voluntary efforts to improve air quality and public health, increase energy efficiency and use of renewable energy, promote economic development, and lower GHG emissions. The branch builds state and local capacity to

make informed decisions by providing tools and analysis such as a new screening tool called the Co-Benefits Risk Assessment (COBRA) model. At Wisconsin's request for assistance to get a better handle on the co-benefits of fuel switching under its Climate Change Action Plan, EPA developed COBRA to quickly estimate air quality, human health, and associated economic impacts of state-level emissions reduction scenarios. Beta models of the COBRA model now exist in 10 states, including NY, WI, GA, NC, DE, WA, CT, MA, and PA.

COBRA users enter air emissions data (e.g., SO_2, NOx) into the model and COBRA quantifies changes in particles (against business-as-usual air emissions estimates), calculates health effects and associated monetary value (e.g., mortality, asthma ER visits), and visually maps the benefits. COBRA is easy to use, flexible (user can enter data for a single county, group of counties, or statewide in absolute terms or as a percent change), quick, and seeks to enrich discussion of co-benefits for states. However, the COBRA model is perhaps too simplified (e.g., serves as a screening tool or short cut for decision makers, relies on inputs generated elsewhere). Specific geographical reductions and fuel displacement (e.g., which fuel, at what plant, in what county) would greatly enhance analysis. Denise provided a sample scenario for New York switching to wind power to demonstrate COBRA's capabilities (see screen captures and tables in presentation). Based on inputs and various percent change reductions in emissions, COBRA calculates the state-wide and national monetary benefits of switching to a greater percentage of wind power. EPA will continue to refine the model and perform a technical peer review in late 2004. EPA also is looking for ways users can improve their input data (e.g., specific geographic location) for more accurate results.

Energy Modeling Applications of Valuation of Emissions Reductions from Renewable Energy

Dallas Burtraw, Resources for the Future (RFF), presented "Estimates of Emission Effects and Their Potential Uses in Energy Modeling," which provided an overview of what can be done to link energy and environment models and what could go wrong. Dallas pointed out distinctions between regulatory (litigation) support modeling and model development for policy and planning purposes as a call for integrated assessments and departure from mega or full-form models. He presented results from tracking analysis conducted for the benefits and costs of Title IV to demonstrate how some of the correlation between science and economics were dropped because linkage could not be made. Dallas emphasized that difficulties in integrating models gets back to the issue of when green power is added in one area, where are the greatest reductions realized? He also highlighted other major research issues and uncertainties with health-related benefit valuation including location and types of sources, long-term exposure and disease, and valuation of children and elderly groups (i.e., vulnerable populations). He noted that health benefits are the predominant part of the benefits value, not only because health is highly valued, but also because we are less familiar with other benefits pathways.

Dallas also discussed what could go wrong with benefits valuation. Problems arise because the value of emissions reductions is ill-defined and varies by state (the study was purposefully

conservative to account for all pending legislative proposals but studies suggest that emissions limits could be more stringent), There also is a difference between new and existing generation and the exclusion of nonhealth pathways could be significant (see presentation for more detail). Models might also fail to account for times when marginal damage is not an externality (e.g., transboundary effects) or the emission responses vary with policy. He closed by pointing out that integrating energy and environment models is useful for research priorities and policy analysis and more reduced-form or accessible models—such as BenMAP and COBRA—could serve beneficial purpose.

Including Environmental Effects Valuation in Energy Modeling in NEMS: Prospects, Issues, and State Data

Zia Haq, Energy Information Administration (EIA), delivered a presentation entitled "Environmental Externalities and State Regulatory Initiatives." Zia explained that EIA is new to the arena of environmental externalities and the complexity associated with incorporating externalities into an energy modeling framework (e.g., site specific variations, seasonal fluctuations). He briefly discussed the NEMS model and how its linear function evaluates future capacity decisions based strictly on economic factors. He continued with a review and evaluation of existing externality models. One limitation of externality models is the data needs (e.g., geographic population distribution, background levels of pollutants, local topography). Zia described several issues and challenges for externality modeling, including mercury fate and transport, valuation of premature mortality, estimating impacts from climate change, and health impacts of particulate matter. Due to these challenges, EIA's next Annual Energy Outlook 2004 (AEO2004) report will not have environmental externalities. However, AEO2004 will include information on several state environmental legislative issues that begin to examine these challenges (e.g., 10 states have enacted air emission regulation that impact the electricity generation sector). Mercury is a primary pollutant of concern—along with SO_2 and NOx—and Zia provided several example of state enacted and proposed initiatives that will severely impact future air emissions (see presentation for detailed state discussions). He concluded with a perspective on the various state initiatives as a whole, emphasizing significant impact from North Carolina's "Clean Smokestack Act," proposed mercury regulations, and proposed Northeastern CO_2 cap and trade initiative.

Wrap-up

The afternoon session concluded with discussions on how best to integrate environmental information into energy models. Mary Beth Zimmerman ((DOE) raised the question if the intent was to take a mega model and create a reduced-form model to measure environmental externalities, or expand energy modeling to include benefits as well as costs. Bryan Hubbell (EPA) interjected that it will be important to identify and compare the various pieces of individual models and how to assemble them to work together (e.g., BenMAP data into NEMS). Dallas Burtraw (RFF) commented that, understandably, not every model can answer every

question but it's significant to know which questions to ask. Sam Baldwin (DOE) noted the importance of propagating uncertainty throughout calculations and also running lots of different scenarios, in order to get a better perspective on future possibilities. Tom Petersik (EIA) raised the question of whether the goal was to place a value on externalities, and, if so, what steps were needed to do so, how markets vs. non-market issues could be distinguished, and how benefits could be integrated into analyses. There was discussion of how NEMS and EPA models might be used together to improve the environmental modeling of the energy system—in particular to identify where new generation is likely to locate—and to deal with the issues of identifying the expected spatial distribution of emissions even when there are cap and trade programs. Susan Holte (DOE) raised the issues of how decision-making happens and the challenges of modeling more complex elements in addition to the purely financial motivations for decisions. Juanita Haydel (ICF Consulting) elaborated on the imperfections in modeling consumer behavior and the challenges of simplifying complex decisions within a modeling framework. Mary Beth added that energy modeling is different than modeling for other industry sectors (e.g., transportation). For example, do we want to—and how can we—model electricity demand not as just a commodity in which all kilowatt hours are the same, but as a consumer good like a car, where different products and customers are modeled very differently. She also voiced her concern that we might run the risk of thinking we know what people want based on market influence (e.g., economic models), regardless of societal benefits (i.e., environmental externalities). Skip Laitner (EPA) stated that more work needs to be done to identify how environmental attributes might impact these economic models. Several participants indicated how they see the integration of environmental externalities could supplement existing information and expand green power purchasing, since many are already buying in the absence of these additional benefits (e.g., reduced health impacts) and regardless of price.

Significant time also was spent discussing RECs and how to improve understanding of consumer preference and market penetration. Participants identified the need for companion models to help answer where to build green power sources in order to maximize environmental externalities (e.g., reduce emissions in air quality nonattainment zones) and achieve greatest impact. Bryan Hubbell (EPA) stated a lot could be learned by tracking REC purchases to help determine where/how the power is produced and learn the associated impacts (e.g., reduced air emissions, improved air quality).

Lastly, attendees discussed some of the transport and boundary issues or concerns associated with using NEMS (i.e., absence of "local" county or state information since it is based on 13 regions). Participants agreed NEMS should be viewed as a gross model. To generate a more accurate picture, modelers also have to know what else might be going on in that area that impacts emissions (e.g., efforts to expand commuter programs and remove cars from the road). These limitations are significant in relation to the idea of producing cost or benefit values on a per kWh basis, because such numbers are only locally accurate and depend on baselines, what else is done, and which pollutant is being examined.